017

speed controller for model train

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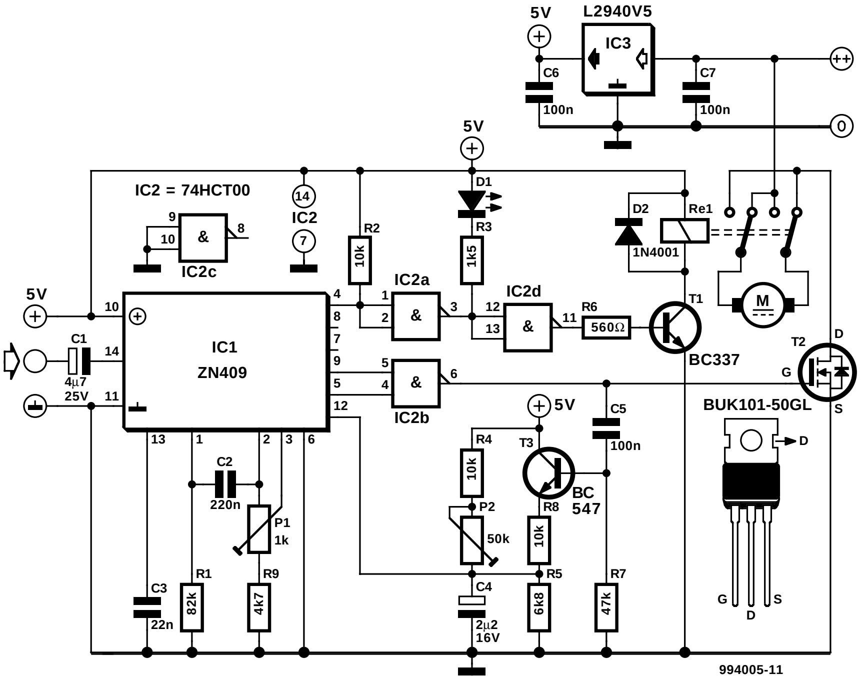
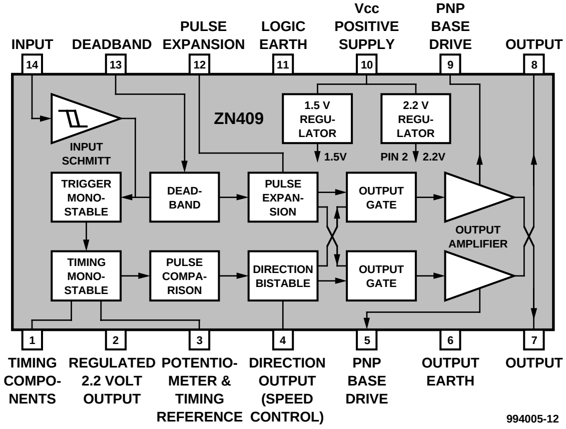
The Type ZN419CE servo control IC from Ferranti is ideal for use in model railway direct-current engines. The internal circuit diagram of this device is shown in **Figure 1**. The IC varies the pulse width of input pulses in direct proportion to the displacement of a potentiometer. It operates with positive-going input pulses which can be coupled directly or via a capacitor to input pin 14. The advantage of a.c. coupling is that should a fault occur which causes the input signal to become a continuous level, the servo will remain in its last quiescent position, whereas with direct coupling the servo output arm will rotate continuously

The active input is a Schmitt trigger input (pin 14), which allows the servo to operate consistently with slow input edges and supplies the fast edge required by the trigger monostable independent of input edge speed. The input pulse is compared with the monostable pulse in a comparison circuit and one output is used to enable the correct phase of an on-chip power amplifier. Additional, a deadband, that is the period during which the motor must not move, is effected by capacitor C_3 between pin 13 and earth.





Any difference between the input and monostable pulses is used to drive the motor in such a direction as to reduce this difference so that the servo takes up a position that corresponds to the position of the potentiometer in the controller.

The relation between the setting of the joystick on the controller and the duty factor of the output signal (0–100%), which determines the speed of the engine, depends on the potential at pin 12. This potential is set with P_2, while the rest position of the joystick and the motor is set with P_1.

The potential at pins 5 and 9 are applied to the inputs of NAND gate IC_{2b}. The pulse-width modulated (PWM) output of this gate is applied to TTL-compatible power MOSFET T_2, which switches the motor. The PWM signal drives the pulse expansion circuit via C_5 and T_3. In this way, pulses that are only just outside the dead-band are expanded, which improves the control over the motor.

The potential at pin 4, which decides the direction of travel, is applied to relay Re_1 and Re_2 via gates IC_{2a} and IC_{2d}, and buffer T_1. The relays serve to reverse the polarity of the motor. The direction of travel is indicated by diode D_1. When the relays are in the rest position, the direction of travel should be forward, since their rating of 12–16 A applies only to short periods of time.

The supply voltage for the servo is held steady by regulator IC_3. This should be a low-drop type if the input to $K_2 \leq 8$ V; with higher voltages, a standard 7805 may be used. The supply voltage for the motor is, of course, not regulated.

Transistor T_2 can handle currents of up to 25 A. If a higher current is needed, two of these transistors can be connected in parallel. A somewhat less expensive transistor is the BUK100 which can handle currents of up to 13 A.

If a printed-circuit board is used for the construction, it should be capable of working with the high currents mentioned earlier (separation of tracks!).

The motor should be decoupled for noise and interference by ceramic capacitors rated ≥ 50 V: 0.01 µF between casing and earth and 0.01–0.1 µF across the terminals.

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